Differential preservation of biological information under the global acidic conditions on Mars, an approach from the Río Tinto Mars analog and its implications for searching extinct life on Mars. D. C. Fernández-Remolar[1], C. Menor-Salván[1] and M. Ruíz-Bermejo[1]. [1]Centro de Astrobiología (INTA-CSIC), Ctra Ajalvir km 4, 28850 Torrejón de Ardoz, Spain, fernandezrd@inta.es.

Introduction: Planetary data provided by robotic missions to Mars have allowed to characterize early potential habitats as acidic [1, 2]. Iron oxide and sulfate deposits detected in distant regions as Meridiani, Valles Marineri or Gusev [3] suggest that the acidic conditions were global and likely driven through volcanic outgassing of sulfur-bearing compounds [4], which induced the production of acidic solutions recorded as ferric-bearing mineralogies of sulfates and oxides [5].

Despite of these extreme conditions, it has been reported that biological information can be recorded under similar physicochemical conditions as several geobiological entities ranging from microstructures to organic molecules [6, 7]. Having this in mind we provide new information concerning to preservation potential in Río Tinto depending on environmental gradients fixed to acidic-oxidizing surficial conditions characterized by heavily concentrated solutions in iron and sulfate. Accordingly, distinctive biological markers are differentially preserved depending on the prevailing environmental conditions.

Preservation in the Río Tinto extreme environment: Research of surficial and subsurface environments of Río Tinto has provided a new picture of this weird environment that in surface occurs as a low-pH extreme habitat (Fig. 1). Integration of physicochemical and geochemical data obtained in modern environments, and old deposits [6, 8] allow to recognize two main geochemical gradients depending on temporal and spatial geochemical parameters based on different biogeochemical processes [9]. Obviously, they have a strong imprint in the preservation state of the biological information left by the micro- and macroorganisms taking part in the Río Tinto communities.

As a result of such integration, two different environmental gradients emerge, one depending on pH and redox changes in modern and recent environments; and other, following aging-related mechanisms of iron-rich deposits. In the first one, pH and redox-driven gradient links preservation windows under acidic and oxidizing surface conditions to quasi-neutral and reducing conditions (Fig. 1). Strong acidic and oxidizing conditions of surface induce preservation of morphology [6], given that the biological structures are rapidly coated by Fe(III)-SO_4 bearing compounds. However, organics show a high preservation potential in Fe-rich mineralogies crystallizing under oversaturation and isolating the biomolecules inside single crystals or resistant cryptocrystalline to amorphous infillings [10] (Fig. 2). On the other hand, the reducing and mild-acidic to neutral subsurface environments have low concentration in ions, which prevent massive production of mineral structures preserving biology as observed in surface deposits, but favoring conservation of molecular traces in form of biomarkers like hopanoids. Interestingly, overimposition of acidic and oxidizing conditions over the reducing and mild-acidic to neutral would favor destruction of the subsurface biomarkers.

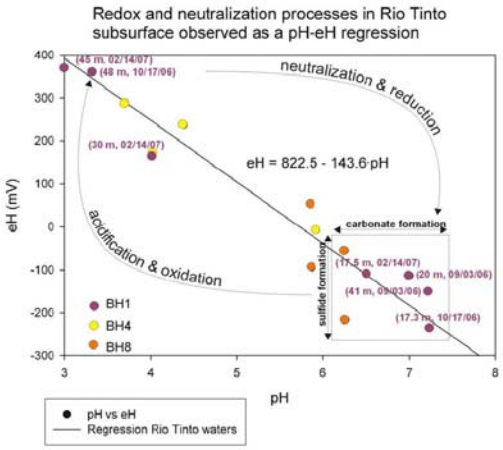

Figure 1. Redox and pH gradients in the Río Tinto basin ranging from strong acidic and oxidizing in the surface to mild acidic-neutral reducing subsurface areas, which are seasonally exposed to oxidizing events. BH1, BH4 and BH8 are boreholes emplaced in different areas of the Peña de Hierro area [9].

Sediment aging of sediments originated under acidic conditions induce the "natural selection" of mineralized biological structures instead other paleobiological traces as biomarkers. TOC comparative analyses between modern Río Tinto deposits and two million-of year iron rich sediments originated under the same acidic conditions show decreasing carbon concentration over time (1-2 % in modern deposits to < 0.1 % in the old sediments). The sediment-aging processes are related to sediment exposure to oxidizing meteoric waters, desulfation and dehydration mechanisms that drive to the formation of rocky deposits

solely composed of goethite and hematite. Assuming a constant rate of TOC-loss over time, carbon concentration would be negligible in a range of billion of years.

Preservation windows in acidic environments and searching for extinct life on Mars: Results on preservation of paleobiological traces under acidic constraints is a valuable information to use in developing a coherent exploration strategy of the Noachian areas with geological evidences of acidic paleoenvironments. Having in mind that the hydrological activity of early Mars can be far different than those terrestrial, three different areas can be rightly explored using the appropriate instrumentation that is adapted to detect specific paleobiological markers. They can described as the following:

1) Preservation window under oxidizing and acidifying surface conditions of non-aged deposits. Paleobiological structures plus biomarkers in sulfates and poorly crystallized ferric oxyhydroxides will be recognized combining optical to Raman or fluorescence devices and GCMS instrumentation.

2) Preservation window under reducing and mild-acidic subsurface conditions. Neutralization and reduction of oxidizing and acidifying surface solutions entering into the basement would preserve potential biomarkers. GCMS and microarray coupled technology would be an appropriate combination to search for extinct life.

3) Preservation window of surface oxidizing-acidifying window in aged deposits. Surficial deposits exposed during million of years to oxidizing conditions would select mineralized morphologies but destroy organics to highly matured compounds depleted in light fraction. Optical coupled to Raman and UV devices would be feasible instrumentation to search for paleobiological traces in these materials.

Obviously, this is a simplified vision of the possible acidic materials bearing biological information that could have been preserved in the geological record of early Mars. For example, whereas MER Spirit show in Gusev volcanogenetic deposits weathered under acidic conditions; in Meridiani, Opportunity have recognized Aeolian dune porous deposits with cementation by acidic subsurface solutions. Both are somewhat different than the Valles Marineri materials that can be the result of sedimentation below acidic water masses producing sulfates in the same way as some Terrestial salty basins. In this sense, different geochemical processes can have favored differential preservation potential in the primary biological information, which have to be accordingly evaluated using different instrumentation in order to be detected.

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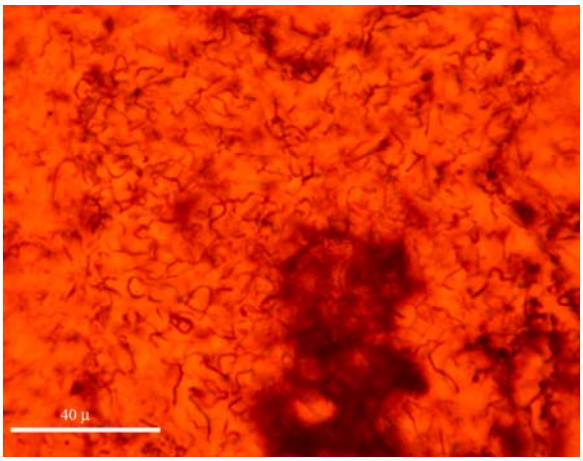

Figure 2. Cryptocrystalline to amorphous texture of an iron-rich mineralogy obtained in a 1500-800 year-old terrace deposit that have isolated filamentous structures preventing its exposure to a changing environment.